

Animal welfare in non-anthropocentric cost-benefit analysis and social welfare functions: A critical review to guide practical application

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Abstract

Cost-benefit analysis and social welfare functions are two closely related methods to evaluate policy impacts. In this critical review, we present the state of knowledge on how to include the animals' (non-anthropocentric) perspective in these policy evaluations. For this, we synthesize material from the scientific and grey literature and develop a checklist that guides through the process of non-anthropocentric cost-benefit analysis and social welfare functions. Step-by-step, the checklist gives an overview of the alternative options and normative assumptions in the literature and points to remaining research gaps.

Keywords: animal welfare; well-being; economics; politics; impact assessment.

JEL classification: Q18

1 Introduction

Agricultural (and other) policies may have impacts on producers, consumers, animals, the environment, climate and other entities. This critical review focuses on impacts on animals. Better representing animals in policy evaluations is an important step towards improving animal welfare, a political goal defined, e.g. in the Farm to Fork Strategy (European Commission, 2020).

A small but growing body of literature has recently emerged to better account for animals in policy evaluations by means of non-anthropocentric cost-benefit analysis (CBA) and social welfare functions (SWFs). This literature involves different disciplines such as economics, animal science, philosophy

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and ethics. Researchers have recently called for the uptake of the novel non-anthropocentric approaches in practical policy advice (Budolfson, Fischer and Scovronick, 2023; Kuruc and McFadden, 2023a). Yet, policy analysts who seek to apply these approaches in practice face substantial challenges because the approaches differ considerably in the methodologies and underlying normative assumptions. Although each of the novel non-anthropocentric approaches is contextualized within the literature, referring to a relevant subset of studies (see, e.g. Budolfson *et al.*, 2024; Espinosa and Treich, 2024b), what is lacking to date is a thorough account of the entire body of literature in this emerging field. Thus, the purpose of this critical review is to present all available approaches to non-anthropocentric CBA and SWFs, covering the different involved disciplines. The results are summarized in a checklist that guides policy analysts through the novel non-anthropocentric approaches and provides a knowledge base for future research in this developing field.

1.1 Non-anthropocentric perspective in policy analysis

Impacts of policies on animals may be evaluated from the animals' own perspective (i.e. non-anthropocentric analysis) or from the perspective of humans who are indirectly affected by the impacts on animals (i.e. anthropocentric analysis). For example, a policy may decrease the incidence of lameness in farmed pigs. From the pigs' perspective, this constitutes an increase in welfare. Policy evaluations that take this welfare increase of pigs directly into account, intrinsically for its own sake, can be considered non-anthropocentric. In contrast, when the pigs' lower incidence of lameness is taken into account only indirectly through impacts on humans (e.g. through human altruism towards animals or through lower production costs for veterinary treatments), the analysis can be considered anthropocentric. This dichotomous distinction has proven useful as a heuristic and is widely applied in the literature (e.g. Fleurbaey and van der Linden, 2021; Treich, 2022; Kuruc and McFadden, 2023b; Espinosa and Treich, 2024a). Yet, throughout this review, we will point out methodological challenges in inferring the animals' perspective that may introduce anthropocentric bias of variable intensity into non-anthropocentric approaches. Also vice versa, human altruism may imply that anthropocentric approaches can have similar characteristics as non-anthropocentric approaches.

1.2 Cost-benefit analysis

CBA is a tool to assess positive and negative impacts of policies. In CBA, impacts are—as far as possible—expressed in monetary units. If certain impacts cannot be monetized, they are disclosed in quantitative, non-monetary units or described qualitatively so that they can nonetheless be considered in decision-making.

In practice, for most policies, impacts on animals are either ignored in CBA or included from the humans' anthropocentric perspective (Stawasz, 2020; Leitzel and Shaikh, 2023; Sunstein, 2024). In CBAs of agricultural policies,

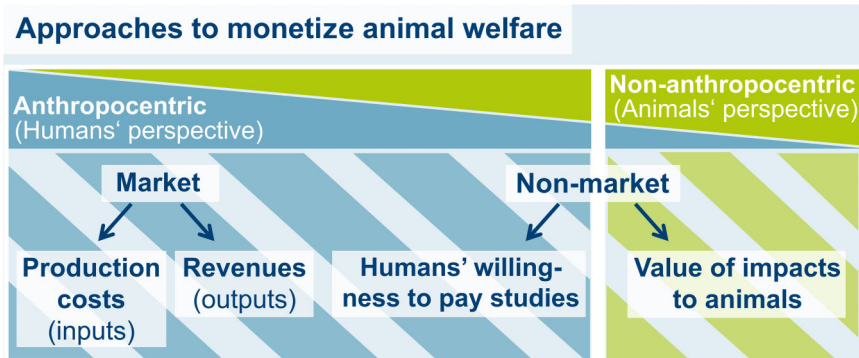


Fig. 1. Approaches to monetize animal welfare in policy evaluations

impacts on farm animals are often monetized from the human perspective. First, from the producers' perspective, impacts on farm animals affect production costs and revenues. This has been used in practice for monetization, e.g. in CBAs at the EU level (e.g. [Wieck and Dusel, 2022](#)), in Germany (e.g. [Deblitz et al., 2021](#)) and in the UK (e.g. [DEFRA, 2013](#)). Besides, multiple literature reviews have addressed costs and benefits to animal producers (e.g. [Brouwer et al., 2011](#); [Dawkins, 2017](#); [Fernandes et al., 2021](#); [Niemi, 2023](#)). Second, from the consumers' and citizens' perspective, impacts on farm animals affect private consumption utility (e.g. perceived meat quality, warm glow from contributing to a good cause) and/or altruistic preferences, i.e. the utility humans derive from knowing that animals are treated decently (e.g. [Lusk and Norwood, 2012](#); [Marggraf, Masius and Rumpf, 2012](#); [Eichner and Runkel, 2022](#); [Espinosa, 2023](#)). Humans' altruistic and private preferences may translate into purchases of higher-welfare products with a price premium in limited market segments (recently reviewed by [Maestre et al., 2022](#)), but these price premiums are generally known to fall short of the values elicited in research settings ('citizen-consumer gap'). The literature on human willingness to pay for farm animal welfare has been intensively reviewed ([Cicia and Colantuoni, 2010](#); [Lagerkvist and Hess, 2011](#); [Clark et al., 2017](#); [Yang and Renwick, 2019](#)). Information on human willingness to pay for farm animal welfare regularly feeds into CBA in practice (e.g. [DEFRA, 2017](#); [Wieck and Dusel, 2022](#)), and plays a prominent role in the policy process (e.g. [Eurobarometer, 2023](#)). Humans' altruistic preferences may be more or less accurately aligned with animals' preferences ([McInerney, 2004](#); [Treich, 2022](#); [Espinosa, 2023](#)). The more these preferences are aligned, the more the analysis gains characteristics of non-anthropocentric approaches (Fig. 1).

For policies with the primary purpose to improve animal welfare, impacts are already considered from the animals' (non-anthropocentric) perspective in practice in CBA. This is the case, for example, for farm animal welfare policies in the EU (e.g. [Wieck and Dusel, 2022](#)) and in the UK (e.g. [DEFRA, 2010b](#)), and for marine wildlife protection in the USA ([National Oceanic](#)

and Atmospheric Administration, 2016 cited in Sunstein, 2024). However, importantly, in these studies the impacts are not yet monetized from the non-anthropocentric perspective but remain descriptive or expressed in quantitative, non-monetary units instead (see also Sunstein, 2024). Even these non-monetary impacts can often only be broadly approximated because data on the situation of farm animals is scarce in practice (Dusel and Wieck, 2023).

Novel non-anthropocentric approaches go further and attempt to monetize impacts from the animals' perspective. Money is a convenient unit because producers' costs are readily available in monetary units. These costs feature prominently in public debates, which makes it appealing to also express impacts on animals in monetary units. By this, costs and benefits to humans and animals could be directly compared on the same (monetary) scale (Budolfson, Fischer and Scovronick, 2023). The ideal preconditions for non-anthropocentric monetization in CBA would be if animals acted as economic agents in an "interspecies market" (Keeler, 2016: 721), making their own economic choices with their own income and willingness to pay, in competition with humans. Of course, animals do not interact with us this way, and they do not use money, and this poses an important obstacle to non-anthropocentric monetization in CBA (Stawasz, 2020; Leitzel and Shaikh, 2023; Sunstein, 2024). As workarounds, various approaches have been suggested to infer the animals' monetary valuation of policy impacts, and these approaches are the subject of this critical review.

1.3 Social welfare functions

Given the challenges associated with the non-anthropocentric monetization of impacts on animals, an alternative is to assess these impacts on the same scale as impacts on humans by using 'well-being units' instead of monetary units. This is the basic principle of SWFs (e.g. Adler, 2019: 32, 41–7). For example, quality-adjusted life years (QALYs) may serve as well-being units, though they only measure well-being related to health and longevity, which underestimates overall well-being of humans and animals (e.g. Espinosa and Treich, 2024b). Notwithstanding, it is also possible to use money as a welfare metric in SWF, but, in contrast to CBA, this is not imperative (Adler, 2019: 32)¹.

SWFs are not yet applied in practical policy evaluations, and the SWF methodology is not included in the EU's Better Regulation Toolbox, a handbook with guidelines for policymaking at the EU level (European Commission, 2023). However, as methods to include animal welfare in SWF gain traction in the literature (Budolfson, Fischer and Scovronick, 2023; Kuruc and McFadden, 2023a), we consider it the right time to explore these approaches in this critical review.

SWFs share some similarities with life cycle assessments (LCAs), which already feature in the EU's Better Regulation Toolbox (European

¹ In fact, CBA with distributional weights can be considered an approximation of various SWFs, particularly utilitarian ones but also others (Adler, 2016; Adler, 2019: 37).

Commission, 2023: 571–6). In LCAs, animal welfare is mostly comprised in the social dimension (Lanzoni *et al.*, 2023) and evaluated along with other social aspects such as human health (Minetto Gellert Paris *et al.*, 2024) and local communities (Zira *et al.*, 2021). However, as the goal of LCAs is to compare production systems or product footprints rather than to aggregate well-being in society, the impacts on different social entities do not necessarily have to be expressed on the same scale.

1.4 Other methods

Cost-effectiveness analysis, breakeven analysis and multi-criteria decision analysis (MCDA) are further methods for the non-anthropocentric evaluation of animal welfare policies (reviewed by Stawasz, 2020).

In cost-effectiveness analysis (CEA), costs are monetized, but benefits are expressed in a quantitative non-monetary unit. In contrast to CBA, where the scope is broad to capture all possible positive and negative impacts, CEA usually focuses on specific costs and relies on a single quantitative metric for benefits to enable comparisons across policy options (Boardman *et al.*, 2018: 519, 531). In the EU, the UK and Germany, CBA with qualitative or quantitative non-monetary impacts appears to be favoured over CEA, as we could not find any practical examples of animal welfare in CEA. Yet, CEA does feature in the EU's Better Regulation Toolbox (European Commission, 2023).

Breakeven analysis is a simplified version of CEA where the costs of policies are broken down, for example, per animal (Stawasz, 2020). Breakeven analyses are regularly carried out for farm animal welfare policies in the EU (e.g. Rayment *et al.*, 2010), the UK (e.g. DEFRA, 2010a) and in Germany (e.g. Federal Ministry of Food and Agriculture, 2024).

MCDA describes an array of different methods that serve to map impacts along different dimensions (e.g. Stawasz, 2020; Dean, 2022). MCDA features in the EU's Better Regulation Toolbox (European Commission, 2023), and a comprehensive MCDA was recently carried out by Milieu Consulting (2023) for the revision of the EU legislation on animal transport. Other than that, we could not find examples of animal welfare in MCDA in practice.

Although formally easier to apply, all three methods entail the disadvantage that costs to producers and benefits to animals cannot be directly compared on the same scale. Hence, it remains unclear for which policy option the benefits outweigh the costs, and policymakers face difficulties in deciding which policy option is preferable (Budolfson, Fischer and Scovronick, 2023).

2 Methodology

This critical review covers the non-anthropocentric monetization of impacts on animals in CBA and the non-anthropocentric representation of animals in SWF.

The review objectives are to synthesize the available material, to make transparent any conflicting normative assumptions and to present the results

in a way that enables policy analysts to make informed normative choices for practical application of the methodologies. Besides, this review aims to facilitate an academic debate on normative controversies in the field and to point out any remaining research gaps.

The format of a critical review fits our research objectives because critical reviews “‘take stock’ and evaluate what is of value from the previous body of work” (Grant and Booth, 2009: 93) and “‘reveal weaknesses, contradictions, controversies, or inconsistencies” (Paré *et al.*, 2015: 189). Our frame of analysis (see [Supplementary data](#)) is based on the guidelines for critical reviews by Wright and Michailova (2022).

The search process consists of a database search in EconLit and Scopus, including preprints (see [Supplementary data](#)). Further, similar as described by Wohlin (2014) for systematic reviews, we adopt a multi-tier backward and forward snowballing approach in the scientific and grey literature. This covers studies that were citing, cited, cited-by-cited etc., and also searches for specific authors and conferences (Wohlin, 2014). Moreover, we include documents that we know from our own experience in practical policy advice (Wieck and Dusel, 2022; Dusel and Wieck, 2023; Niemi, Wieck and Dusel, 2023).

We consider it important to include the grey literature because (i) preprints and working papers allow us to be up-to-date in this emerging field, and (ii) practical policy documents published by governmental bodies or consultancies are relevant in this context. In total, the full texts of 73 publications are included in the critical review.

Critical reviews are often criticized for being non-systematic and subjective because formal criteria to present methods and results and to assess the quality of the included studies are lacking (Grant and Booth, 2009; Paré *et al.*, 2015). Although not fully eliminated, we believe that these drawbacks are somewhat mitigated in this critical review because we describe our frame of analysis, explain in detail the search process and adopt rather broad inclusion criteria (see [Supplementary data](#)).

3 Results: Checklist

The results of the critical review are presented in the form of a checklist. For each step in non-anthropocentric CBA and SWFs, the checklist gives an overview of the normative alternatives explored in the literature and points to any remaining research gaps.

3.1 How should welfare be measured?

3.1.1 Which fundamental concept of welfare should be adopted?

In the welfare economics literature in general (e.g. Adler, 2019: 10–11), and in the studies on non-anthropocentric CBA and SWF (e.g. Horta, 2017, 2018; Schukraft, 2020a; Fleurbaey and Leppanen, 2021; Visak, 2022: 13–4; Browning, 2023), three main concepts of welfare are distinguished: experientialism (particularly, hedonism), preferentialism, objective-good concept.

Adopting the concept of welfare involves normative judgement (Bruckner, 2020; Visak, 2022: 58–9).² It is possible to assume welfare variabilism, meaning that different concepts of welfare are applied depending on the species, or welfare invariabilism, where the same concept is applied to all species (Schukraft, 2020a). Not all studies address and specify the concept of welfare; some rather provide a general framework that would be compatible with multiple concepts of welfare and with welfare variabilism or invariabilism (Table 1). In the reviewed literature, the studies exploring specific welfare concepts work with welfare invariabilism.

A) Hedonism

For non-anthropocentric CBA and SWF, hedonism is the only relevant experientialist concept of welfare in the literature. In hedonism, welfare is determined by feelings of pleasure or suffering.

Hedonism features in the most advanced studies in the field, those that develop a theoretical framework and spell it out from beginning to end with empirical data for specific cases (i.e. studies that include a parameterized example; see Table 1). The study by Rusman *et al.* (2023) is an exception, as it provides a parameterized example without addressing the underlying concept of welfare.

Fleurbaey and Leppanen (2021: 271) criticize hedonism for being “partly anthropocentric” because mental states matter a lot to humans, but this may not be true for other species. Hence, if only mental states count for welfare, humans receive implicit priority over other species (Fleurbaey and Leppanen, 2021). Instead, Fleurbaey and Leppanen (2021) suggest accounting for differences between species with the preferentialist or objective-good concept of welfare. Fischer (2022) compares the effects of adopting hedonism versus the objective-good concept, under the assumption that the hedonic goods on the list outweigh the non-hedonic goods for all species. Under this assumption, hedonism leads to 3× smaller, or more cautiously, 10× smaller, estimates of the capacity for welfare than the objective-good concept, independently of the species (Fischer, 2022). However, these estimates do not account for any possible differences in the weighting of hedonic vs. non-hedonic goods across species, meaning the criticism of anthropocentric bias raised by Fleurbaey and Leppanen (2021) remains unaddressed.

Espinosa and Treich (2024b) acknowledge the arguments against hedonism by Fleurbaey and Leppanen (2021). In response, Espinosa and Treich (2024b: 19) adopt a “hybrid approach mixing the hedonistic and objective list approach”. However, based on Visak (2022: 64–5), we would rather characterize their approach as hedonism using resource-, management- and animal-based information (see Section 3.1.3) to infer hedonic welfare states.

² Bruckner (2020) describes the process of forming a concept of (animal) welfare as a reflective equilibrium bringing together normative beliefs and empirical observations. Normative beliefs on what welfare means determine the tools and indicators used in empirical studies to investigate welfare (Bruckner, 2020; Visak, 2022: 11), and empirical results inform and alter normative beliefs (Bruckner, 2020).

Table 1. Overview of assumptions explored in key studies on non-anthropocentric CBA and SWF.

Study	Welfare measurement				Aggregation across individuals				Monetization				
	Concept of welfare	Welfare capacity	Normalization	Indicators	Scale values	Weights	Rule	Population size	Human altruism	Units	Utility of money	Basis	Parameterized
Blackorby and Donaldson (1992)	-	-	-	Utility of feed	Positive, neutral, negative	Possible	CLU	Imp, Non-ex, Larder	No	Not specified	Equal	-	No
Browning (2023)	Hedonism	Different, equal	Possible	Not specified	Not specified	Ethical possible	-	-	-	-	-	-	No
Bruers (2022)	-	-	-	-	Positive, neutral, negative	-	NRU, VCLU, Minimax	Pers	-	Not specified	-	-	No
Budolfson et al. (2024)	Hedonism, preferentialism (not specified)	Different (neuron count)	Yes	-	Positive, negative, neutral?	Empirical (neuron count), Ethical	Not Specified	Not specified	No	QALY or money	Different	QALY	No
Budolfson and Spears (2020)	-	Different (neuron count)	-	-	-	Empirical (neuron count)	TU	Imp, Non-ex, Larder	-	Not specified	Different	-	No
Eichner and Runkel (2022)	-	-	-	Land input per animal	Negative	Ethical	TU	Imp, Non-ex, Larder	Optional: PA with weight	-	-	-	No
Espinoza (2023)	Hedonism	Different (neuron count)	Yes	Five freedoms	Positive, neutral, negative	Empirical (neuron count), Ethical	TU	Imp, Non-ex, Larder	Altruism (not specified) with weight	Money	Different	QALY	Yes

Table 1. Continued

Study	Welfare measurement					Aggregation across individuals				Monetization			
	Concept of welfare	Welfare capacity	Normalization	Indicators	Scale values	Weights	Rule	Population size	Human altruism	Units	Utility of money	Basis	Parameterized
Espinoso and Treich (2024b)	Hybrid: hedonism and objective-good	Different (neuron count)	Yes	Five freedoms	Positive, neutral, negative	Empirical (neuron count), Ethical	TU	Imp, Non-ex, Larder	No	Money	Different	QALY	Yes
Espinoso and Treich (2024c)	–	Different (neuron count)	Yes	Five freedoms	Positive, neutral, negative	Empirical (neuron count), Ethical	TU, AU, CLU, NDU, PR	Imp, Non-ex, Larder	Optional: PA with weight	Money	Different	QALY	Yes
Faria (2014)	–	–	–	–	–	–	PR, EGA	–	–	–	–	–	No
Fischer (2023)	Hedonism	Different	Possible	–	Positive, neutral, negative	Empirical	–	–	–	DALY	–	–	Yes
Fleurbaey and Leppanen (2021)	Objective-good (preference-based weights possible), preferentialism	Different, equal	No	Not specified	–	–	–	–	–	–	–	–	No

Table 1. Continued

Study	Welfare measurement			Aggregation across individuals					Monetization				
	Concept of welfare	Welfare capacity	Normalization	Indicators	Scale values	Weights	Rule	Population size	Human altruism	Units	Utility of money	Basis	Parameterized
Gaffney <i>et al.</i> (2023)	Hedonism	Different, equal	Yes (within species), No (cross-species comparison)	Not specified	Positive, neutral, negative	-	-	-	-	-	-	-	No
Horta (2016)	Hedonism	Not specified	-	-	Positive, negative, neutral?	Empirical	PR, EGA	-	-	-	-	-	No
Johansson-Stenman (2018)	-	-	-	-	-	Possible	TU	Imp, Non-ex, Larder	Optional: PA, IA with weight	Money	Equal	-	No
Kuruc and McFadden (2023b)	Hedonism	Not specified	-	None	Negative	Ethical	TU, CLU	Imp, Non-ex, Larder	-	Utils or money	Different	Poverty line (1.90\$/day)	Yes
Lusk and Norwood (2012)	Preferentialism	Not specified	-	WTD feed or other resources	Not specified	Ethical	CBA	-	Optional: PA with weight	Money	Different (Equal possible)	Market prices (feed, other)	No

Table 1. Continued

Study	Welfare measurement			Aggregation across individuals					Monetization				
	Concept of welfare	Welfare capacity	Normalization	Indicators	Scale values	Weights	Rule	Population size	Human altruism	Units	Utility of money	Basis	Parameterized
Marggraf <i>et al.</i> (2012)	Preferentialism	Not specified	–	WTD feed or other resources	Positive, neutral, negative	Possible	TU, AU, CLU, Rawlsian SWF, CBA	Not specified	Optional: PA, IA with weight	Money	Equal	Market prices (feed, other)	No
Rusman <i>et al.</i> (2023)	–	Not specified	–	Pasture, space, transport	Positive, neutral	Not specified	‘True’ Cost Analysis/TU	–	–	Money	Not specified	DALY and neuron count	Yes
Visak (2022)	Not specified	Equal (and review of different)	Not specified	Not specified	Positive, neutral, negative	Not specified	Not specified	Imp vs. Pers (review)	–	–	–	–	No
Visak (2011)	Not specified	–	–	–	Positive, neutral, negative	Not specified	TU, Prior-ex U	Imp, Non-ex vs. Pers (review)	–	–	–	–	No
Zuber <i>et al.</i> (2022)	–	–	–	–	Positive, neutral, negative	Ethical	Various refined	Various refined	–	–	–	–	No

–, Not addressed; AU, average utilitarianism; CLU, critical-level utilitarianism; EGA, egalitarianism; IA, impure altruism; Imp, impersonal view; Larder, logic of the ladder; Minimax, minimax, net-complaint theory; NDU, number-dampened utilitarianism; Non-ex, comparison with non-existence; NRU, neutral-range utilitarianism; PA, pure altruism; Pers, person-affecting view; Prior-ex U, prior-existence utilitarianism; PK, prioritarianism; TU, total utilitarianism; VLU, variable critical-level utilitarianism; WTD, willingness to turn down.

In animal science, subjective experiences play an important role (Gaffney *et al.*, 2023), according to Visak (2022: 63), even a dominant role. Browning (2023) sees hedonism as the most common concept underlying research in animal science. For example, the influential Five Domains Framework by Mellor (2016) can be ascribed to hedonism (Visak, 2022; Browning, 2023: 64). In contrast, Fleurbaey and Leppanen (2021) consider the objective-good concept, including hedonic goods, as the standard concept in animal science. This controversy is not surprising, given that studies in animal science often do not define the underlying welfare concept (Bruckner, 2020; Visak, 2022: 65). Instead, concepts are assigned from the outside perspective, leaving room for interpretation of how animal welfare frameworks and indicators can be linked to welfare concepts.

B) Preferentialism

In preferentialism, the fulfilment of the individual's own preferences determines welfare. The frameworks for preference-based non-anthropocentric CBA and SWF (Table 1) are rather basic and not yet connected to actual findings from animal science where animals' preferences are tested experimentally (e.g. Ede, Weary and von Keyserlingk, 2022). Browning (2023: 535) finds preference-based approaches "far less convincing for animals" than for humans, mainly because she suspects self-harming preferences in animals that, unlike for humans (e.g. smoking), could not be accounted for by defining a set of idealized rational preferences. However, Browning (2023) does not provide convincing reasons why this should not be possible. Fleurbaey and Leppanen (2021) acknowledge the existence of problematic preferences in animals (as in humans) but consider it possible to account for them, only this work has not been done yet.

C) Objective-good concept

In the objective-good concept, welfare is determined by the availability of certain goods that do not have to be preferred by the individuals themselves and that are not limited to (but may comprise) experiences such as pleasure and suffering (e.g. Adler, 2019: 11).

Visak (2022: 21–8; 36–40) critically reviews the objective-good approaches by Kagan (2019) and McMahan (1996). She points out that these approaches may have very different implications, depending on whether goods are included that animals and humans can attain to the same extent (e.g. physical health) or not (e.g. playing the piano). In this context, Visak (2022: 25) criticizes the lack of commitment in the literature to any specific list of goods.

Catalogues of welfare indicators, as they are common in animal science, are easily assigned to the objective-good concept, although they may also be considered instrumental for welfare in the other concepts of welfare (Visak, 2022: 65). For example, the animal welfare frameworks on natural living and biological functioning (Appleby and Sandøe, 2002), and also the WOA definition of animal welfare and the Five Freedoms Framework (Fleurbaey and Leppanen, 2021), have been linked to the objective-good concept of welfare.

Fleurbaey and Leppanen (2021) see the main advantage of the objective-good concept in its flexibility to account for differences between species. The main challenge is the need to find weights for the different goods (Schukraft, 2020c; Fleurbaey and Leppanen, 2021). As a solution, Fleurbaey and Leppanen (2021) propose that weights in the objective-good concept could be informed by species' own preferences for goods. For example, in the Five Freedoms' objective-good approach, the freedom to express normal behaviour could be informed by each species' preferences for different behaviours like mobility or social interaction (Fleurbaey and Leppanen, 2021).³

3.1.2 Does the capacity for welfare differ between species?

We define 'capacity for welfare' similar to Schukraft (2020a) and Browning (2023) as the span between the minimum and maximum attainable levels of welfare. An alternative term used for this by Gaffney *et al.* (2023) and Fischer (2023) is 'welfare range',⁴ while Budolfson *et al.* (2024) call it 'welfare potential' and Espinosa and Treich (2024b) speak of 'utility potential'. Depending on the welfare concept (see Section 3.1.1), different approaches have been developed to empirically investigate whether the capacity for welfare differs between species.

A) Different capacity

Presuming hedonism, differences in the capacity for welfare between species are often justified with the biological underpinnings of pleasure and suffering. For example, in a large project, Fischer (2023) investigates one by one which cognitive and emotional capacities are present or absent in different species and derives hedonic welfare capacities from this. Fischer's approach can be criticized for missing the point that different specializations may mean that the presence or absence of capacities would not have the same relevance across species (Fleurbaey and Leppanen, 2021; Visak, 2022: 28). For example, it does not seem plausible that solitary animals suffer because they do not engage in social behaviours like romantic love (Fleurbaey and Leppanen, 2021; Visak, 2022: 28). In turn, from the perspective of a dog, the underdeveloped olfactory capacities of humans could be seen as a deficit reducing welfare capacity (Visak, 2022: 52). Fischer (2023) himself admits that his approach might rather map the variety of hedonic states than their intensity, and he leaves this for further research.⁵

Other studies try out a much simpler approach, relying only on the number of cortical neurons to estimate welfare capacities (Tables 1 and 2). Neuron counts are generally compatible with all welfare concepts, but they feature

3 Instead of an objective-good approach with preference-based weights, this can also be classified as a 'hybrid' approach combining the preferentialist and objective-good concepts of welfare as described by Adler (2012: 159).

4 Fischer (2023) uses the term 'capacity for welfare' to denote the product of 'welfare range' multiplied by lifespan.

5 Fischer (2023) attempts to quantify differences in pain intensity across species but finds too little data.

Table 2. Numerical estimates of the welfare capacity of chickens.

Basis	Budolfson and Spears (2020)	Espinosa and Treich (2024b)	Rusman <i>et al.</i> (2023) based on Scherer <i>et al.</i> (2018)	Fischer (2023)
Welfare capacity ^a Example: Chicken (Human = 1)	Number of neurons $w_1 = 0.001744$ $w_2 = 0.000003042185$ $w_3 = 0.017$ (<i>depending on relationship between neurons and welfare capacity</i>)	Number of cortical neurons $w = 0.0035$	Number of cortical neurons $w = 0.0038$	Complex list of proxies <i>5th percentile:</i> $w = 0.002$ <i>50th percentile:</i> $w = 0.332$ <i>95th percentile:</i> $w = 0.869$

^aRusman *et al.* (2023): “morally adjusted monetisation factor” (see Section 3.3.2)

most prominently in connection with hedonism (Fleurbaey and Leppanen, 2021; Table 1). Using neuron counts to infer welfare capacities is strongly criticized as too simplistic (reviewed by Shriver, 2022), and even those who work with neuron counts acknowledge major deficits and see it more as a proof of principle.

The objective-good concept is generally considered compatible with different capacities for welfare (e.g. Schukraft, 2020a; Fleurbaey and Leppanen, 2021; Fischer, 2022), but Visak (2022: 25) points out that, depending on the types of goods included, equal capacities would also be compatible (see Section 3.1.1).

Schukraft (2020a) takes preferentialism as compatible with different welfare capacities because he hypothesizes that the strength, number and complexity of preferences differ across species, though empirical research on this is lacking to date.

If different welfare capacities are assumed, it is possible to either normalize measured welfare to the species-specific minimum and maximum levels or to compare absolute values across species. In the literature, different terminology exists to describe normalization: Fleurbaey and Leppanen (2021: 279) call it the “maximum principle”, Gaffney *et al.* (2023: 5) describe it as “species-relativized welfare impacts”, and Browning (2023: 537) refers to normalization as the “[s]imilarity in capacity assumption”. The latter wording seems to be counterintuitive but it encapsulates what Fleurbaey and Leppanen (2021) criticize about normalization: Normalization wipes out differences between species because, even if absolute welfare levels differ vastly, two individuals may still be considered equally well-off if species-normalized values are used for comparison. Visak (2022: 36–54) and Horta (2010) review specific methods for normalization that differ with regard to which minimum and maximum values exactly are used (e.g. McMahan’s (1996) native potential account). If these minimum and maximum values are chosen in a way that cements the status quo, normalization can be considered somewhat anthropocentric because the suffering of other species is easier to ignore if it is presented in normalized terms (Fleurbaey and Leppanen, 2021). Consider, for example, dairy cows: If the minimum and maximum values for normalization are derived from current high-yielding breeds, the need for more robust breeds may seem less urgent because welfare levels appear less concerning in relative terms.

B) Equal capacity

Visak (2022: 65) considers the research approaches in animal welfare science more in line with equal capacities for welfare across species than with different capacities. However, she comments on these approaches from the outside perspective because animal scientists themselves do not usually assess the capacity for welfare across species (Visak, 2022: 65). In the few cases where animal welfare scientists do compare welfare states across species, their assumptions on welfare capacity remain implicit but can be assigned to equal capacities (Browning, 2023).

Assuming hedonism, equal capacities can be justified with pleasure and suffering having emerged from shared evolutionary pressures and being grounded in similar structures across species (Visak, 2022; Browning, 2023: 87). Other authors consider hedonism compatible with different capacities for welfare, based on alternative lines of biological reasoning (see A).

On a conceptual level, Visak (2022: 30, 48) argues that preferentialism must imply equal capacities for welfare because having one's preferences satisfied means the same thing across species only the content of preferences may differ, which Visak finds irrelevant at this point.

Whether the objective-good concept entails equal or different capacities for welfare depends on the types of goods included, according to Visak (2022: 25) (see A and 3.1.1).

3.1.3 Which indicators should be used to assess welfare?

A large number of indicators have been developed by animal welfare scientists to assess the welfare state of animals, i.e. how well the animals are doing at a specific point in time.⁶ For the purpose of policy analysis, the indicators are often categorized as resource-based indicators (measuring the animals' physical environment, e.g. space per animal), management-based indicators (assessing husbandry practices, e.g. interventions like tail docking) and animal-based indicators (measuring the impacts on the animals, e.g. gait scoring for lameness) (e.g. European Food Safety Authority, 2012). Compared to the large body of available indicators, the methods to assess animal welfare in the studies on non-anthropocentric CBA and SWF remain remarkably stylized, with the focus on proof of principle.⁷ The lack of animal-based indicators is a source of anthropocentric bias in the current approaches.

A) Resource- or management-based indicators

Eichner and Runkel (2022) use the inverse of the stocking density, approximated by land input per animal, as the animal welfare indicator for their General Equilibrium Model. Of note, this indicator does not relate to the actual space provided to the animals but includes land input for feed production.

In contrast, based on the methodology proposed by Scherer *et al.* (2018), Rusman *et al.* (2023) use (i) stocking densities in the sense of space provided to the animals for broilers, laying hens, and pigs; (ii) number of days on pasture for cattle; and (iii) transport time for all four species as animal welfare indicators.

The studies by Espinosa and Treich (2024b,c) and Espinosa (2023) are based on the Five Freedoms Framework. For different husbandry systems,

6 For a glimpse into the extensive work by animal welfare scientists on welfare indicators, see, e.g. Vandresen, Chou and Hötzel (2024), Harris, Shallcrass and Cohen (2024), European Food Safety Authority (2023) or Vasdal *et al.* (2022).

7 Notably, Kuruc and McFadden (2023b) do not use any animal welfare indicators. Their quantitative results are based on assumptions about negative welfare states of farm animals in combination with standard slaughter age and carcass weight.

violations of the five freedoms are assessed by experts and serve as indicators of animal welfare.

B) Animal-based indicators: preferences

Multiple studies use the animals' willingness to turn down valuable resources (e.g. feed) for other resources as an indicator of animals' preferences (Table 1). But so far, these studies only provide theoretical frameworks without integrating experimental findings from animal welfare science.

C) Animal-based indicators: other

The five-freedoms expert assessment approach (see A, Table 1) may implicitly include animal-based information because this information may or may not influence how experts rate what they believe animals are experiencing. Other than that, the typical animal-based indicators (e.g. injuries, lameness) have not yet been introduced into non-anthropocentric CBA and SWF, although all approaches would be compatible with them.

Importantly, the complex indicator list by Fischer (2023) serves to estimate welfare capacities, not to measure the animals' welfare state at a specific point in time. Theoretical approaches to measure the welfare state at a specific point in time with the same animal-based indicators as welfare capacity have been theoretically developed by Browning (2023). However, applying these approaches in practice would be more difficult than only integrating animal-based indicators that do not capture the welfare state in relation to welfare capacity.

3.1.4 Does the measurement scale cover positive, neutral and/or negative welfare states?

The literature generally distinguishes between positive and negative welfare states and the neutral point where welfare is zero. The measurement scale does not have to be symmetric around the neutral point (Schukraft, 2020b; Fischer, 2023), and the neutral point does not have to coincide with the threshold below which some assume that life becomes not worth living⁸ (Sebo, 2022: 171–2).

A) Restricted scale

The measurement scale is restricted to negative values in the studies by Eichner and Runkel (2022) and Kuruc and McFadden (2023b). Both studies give similar reasons: (i) because the authors find it reasonable to assume that farm animals generally have negative welfare, and (ii) to avoid the undesirable consequence that animal production would have to be increased if animal welfare was positive (see Section 3.2.3).

⁸ For example, some individuals may consider their life worth living even if they have to endure two units of suffering for every unit of pleasure, which corresponds to net negative welfare and a threshold for life worth living below the neutral point (Sebo, 2022: 171–2).

In contrast, [Rusman et al. \(2023\)](#) restrict the scale to non-negative values (i.e. zero or positive values) for ethical reasons based on [Scherer et al. \(2018\)](#) because they assume that loss of life is generally not in the animals' interest.

B) Full scale

Most studies allow for positive, neutral and negative welfare states ([Table 1](#)). These studies either accept the consequence that animal production has to be increased if animal welfare is positive, and/or they find workarounds to avoid this consequence (see [Section 3.2.3](#)).

3.2 How should the welfare of individuals be aggregated to determine which policy is optimal for society?

3.2.1 *Should weights be used to give different priority to individuals depending on their species?*

The weights discussed in this section determine how much the welfare of different individuals counts in society depending on the species.⁹ This corresponds to what [Browning \(2023: 531\)](#) refers to as the “moral problem”.¹⁰ Similar to [Browning \(2023\)](#), we distinguish between studies that assign weights based on empirical reasoning (i.e. empirical weights informed by biophysiological characteristics of different species) or based on humans' ethical convictions (i.e. ethical weights reflecting humans' attitudes towards protecting different species).

The application of weights is also referred to as the ‘hierarchical’ view on moral status, in contrast to the ‘non-hierarchical’ (also: ‘unitarian’) view without weights (e.g. [Visak, 2022: 123](#); [Kagan, 2019: 2-3](#); [Schukraft, 2020a](#)). The term ‘status-adjusted’ welfare refers to the product of measured welfare (from step 3.1) multiplied by weights indicating moral status, where moral status can either be the same or different across species ([Kagan, 2019: 108](#); [Schukraft, 2020a](#)).

A) No, differences between species are already accounted for in the measurement steps

As laid out in [Section 3.1.3](#), the welfare state of animals at a specific point in time is currently not measured directly on the animals in non-anthropocentric CBA and SWF. At best, expert assessments, as in [Espinosa and Treich \(2024b\)](#), are used to infer welfare states, but this does not capture possible differences in the welfare capacity across species. Therefore, the parameterized studies in the field currently rely on additional weights to depict differences between species.¹¹

9 These species' weights are different from the distributional weights sometimes applied in CBA to correct for differences in income (see also footnote 1).

10 [Browning's \(2023: 531\)](#) “empirical problem” corresponds to [Section 3.1](#) on welfare measurement.

11 Except for the parameterized study by [Kuruc and McFadden \(2023b\)](#), which relies on different income (i.e. different utility of money; see [Section 3.3.2](#)) to reflect differences between animals and humans.

B) Yes, weights should be applied based on empirical reasoning

Budolfson *et al.* (2024), Espinosa and Treich (2024b,c) and Espinosa (2023) use empirical weights to account for differences in the capacity for welfare between species. This is necessary because welfare state and welfare capacity are measured separately in their studies (see Sections 3.1.2 and 3.1.3). To translate these measurements to a common scale that covers all species from low to high welfare capacities, weights based on species' neuron counts are applied to the measured welfare states. These neuron-based weights are not intended as weights in the sense of a hierarchical view on moral status but serve as surrogates for species' welfare capacities.¹²

Following from the concept of status-adjusted welfare (Kagan, 2019: 108; Schukraft, 2020a; see Section 3.2.1), it leads to the same results if the *same* empirical mechanisms either determine welfare capacities in the measurement steps or serve to infer weights for aggregation.¹³ However, if welfare is not measured in the same terms as welfare capacity, it remains unknown whether these empirical mechanisms are actually the same. Mathematically, assigning weights is equivalent to modifying the utility functions of the species in the measurement steps (Blackorby and Donaldson, 1992; see supplements).

When applying weights during aggregation, it is important to keep in mind that these weights can overturn the results from the measurement steps, i.e. if measurements result in a certain ranking of species' welfare states, weights can change this ranking. Expanding on an example by Espinosa and Treich (2024b): Even if measurements showed that a pig and a human experience equal welfare states in a specific situation, weights can lead to the result that, e.g. the pig's welfare counts less in society than the human's. This means that, through weights, equal interests of individuals from different species may not receive equal consideration (e.g. Kagan, 2019: 108; Schukraft, 2020a; Horta, 2016, 2017, 2018).¹⁴ Espinosa and Treich (2024b) acknowledge this consequence of their approach, although they do not see the neuron-based scaling factors as weights, and they are dissatisfied with this result. As a possible solution, they suggest adjusting the neuron-based weights when there is reason to assume that individuals of different species experience equal welfare states. But this is only a workaround to a problem that arises because animals' welfare states and welfare capacities are measured separately with different indicators so that possible differences between species have to be reflected through weights.

In contrast, Kagan (2019: 54–6, 99) accepts that equal interests of different species may not receive equal consideration and gives a striking example: If a mouse and a human were drowning and had the same interests at stake (e.g.

¹²Although not intended as weights, the neuron-based 'scaling factors' act just like weights mathematically (see supplements).

¹³Hence, if Budolfson *et al.* (2024), Espinosa and Treich, 2024b,c) and Espinosa (2023) developed a measurement approach that could capture welfare as a function of neuron counts, the additional neuron-based weight would amount to the double-discounting that Schukraft (2020a) warns of.

¹⁴As reviewed by Zuolo (2017), the principle of equal consideration of interests originally goes back to Peter Singer (1993) and has become popular in animal ethics.

equally intense pain), it would be very counterintuitive to flip a coin to decide who should be saved. Kagan (2019) provides several lines of argumentation to support this intuition, but this goes beyond the scope of this review.

C) Yes, weights should be applied based on humans' ethical convictions

A number of studies feature ethical weights that reflect the level of anthropocentrism in society, i.e. humans' attitudes towards protecting animals in general and their inclination to (dis)favor other species (Table 1).¹⁵ Ethical weights can be determined, for example, through ethical deliberation and public surveys (see Section 3.4), and they can be applied in addition to, or instead of, weights based on empirical reasoning.

Giving somewhat lower priority to animals could be justified with human self-care because humans need to sustain their own species first, before they can protect other species (Sebo, 2022: 157–8).

The ethical weight of animals in current laws is lower than that of humans; otherwise, animals could not be used for food production (Francione, 2010). However, laws are not the same as ethical convictions of society; laws also reflect political bargaining, ancient traditions and other aspects.

Clarke and Ng (2006) determine ethical weights not only for the present but also for future generations of animals. Other than that, the (dis)counting of future generations of animals in relation to humans does not play a role in the literature yet.

Finally, weights based on ethical deliberation can serve as a 'last resort' in policy evaluations when empirical information is not available (Browning, 2023).

3.2.2 Which aggregation rule should be adopted?

The aggregation rule defines how individual welfare is aggregated to societal welfare.¹⁶ In addition to the weights in Section 3.2.1, the aggregation rule may entail weighting based on how good or bad individual welfare is, i.e. different degrees of priority may be given to worse-off individuals.

A) Utilitarianism

Utilitarianism seeks to maximize the overall quantity of welfare in society, and there are different ways how this quantity can be calculated. Utilitarian aggregation rules are currently the most frequently used ones in the field, although they often only serve as proof of principle (Table 1).

¹⁵Other terms used instead of 'ethical weight' are "moral weight" (Espinosa and Treich, 2024b: 7), "degree of anti-speciesism of the social planner" (Espinosa, 2023: 4), "pure species (or political) discount factor" (Budolfson et al., 2024: 13), "non-anthropocentric welfare weight" (Eichner and Runkel, 2022: 2) and "welfare weight" (Kuruc and McFadden, 2023b: 7).

¹⁶The aggregation rules primarily relate to SWFs. In CBA without distributional weights, aggregation is simply the sum of monetary units across individuals. However, distributionally weighted CBA can approximate some SWFs, particularly utilitarian SWFs but also others (Adler, 2016; Adler, 2019: 37).

In total utilitarianism, the sum of individual welfare is maximized. An undesirable consequence of total utilitarianism is the so-called ‘Repugnant Conclusion’, first described by Parfit (1984) and often cited in connection with animal welfare (e.g. Bruers, 2022; Visak, 2022: 133; Espinosa and Treich, 2024c). The Repugnant Conclusion denounces that numbers beat quality, i.e. that a huge population with individuals of very poor welfare would be preferable compared to a population with fewer individuals of higher welfare.

This is mitigated in average utilitarianism, where the mean of individual welfare is maximized. However, this version of utilitarianism also has deficits, in particular the so-called ‘Sadistic Conclusion’, first described by Arrhenius (2000) and also often cited in connection with animal welfare (e.g. Bruers, 2022; Zuber, Spears and Budolfson, 2022). The Sadistic Conclusion entails that it would be preferable to add few individuals with negative welfare than many individuals with positive, but below-average, welfare.

In critical-level utilitarianism, individual welfare is first subtracted by a constant positive threshold value, and then, the sum of the remainders is maximized. Critical-level utilitarianism also leads to the Sadistic Conclusion (Arrhenius, 2000), but Bruers (2022) offers refined versions, called ‘neutral-range utilitarianism’ and ‘variable critical-level utilitarianism’, to avoid this. Essentially, this works by excluding contingent individuals, i.e. those that do not exist in all scenarios (Bruers, 2022). The approach is similar to the ‘prior-existence utilitarianism’ defended by Visak (2011, 2016), where only those individuals count that either already exist or will exist independently of the policy choice under consideration. However, the approaches by Bruers (2022) and Visak (2011, 2016) come at the cost of other undesirable consequences, which are further discussed in Section 3.2.3.

Other refined aggregation rules (not only utilitarian) have been proposed by Zuber, Spears and Budolfson (2022).

B) Prioritarianism and Egalitarianism

In contrast to utilitarianism, prioritarianism and egalitarianism seek to reduce inequalities in the distribution of welfare across individuals, giving priority to worse-off individuals even if this does not maximize overall welfare in society. Prioritarianism achieves this by focusing on the absolute welfare level of each individual, whereas egalitarianism is concerned with the individual’s welfare level relative to the other individuals in society (e.g. Adler, 2019: 89, 93).¹⁷

Prioritarianism and egalitarianism often require the same actions to be taken (Faria, 2014; Horta, 2016) and have a similar standing in the literature, where they are currently only discussed on a rather general level.¹⁸ There-

¹⁷More technically speaking, the key difference is that prioritarianism satisfies the Separability Axiom whereas egalitarianism does not (e.g. Adler, 2019: 105).

¹⁸Though from the anthropocentric perspective, where animal welfare is taken into account only through human altruism, a comparatively detailed, formal exploration of egalitarianism is available in Fleurbaey and van der Linden (2021).

fore, prioritarianism and egalitarianism are covered in the same section, even though they are separate aggregation rules.

[Espinosa and Treich \(2024c\)](#) briefly introduce a framework of equations for prioritarianism but find it too challenging to parameterize, given strong normative choices that would have to be made. [Horta \(2016\)](#) and [Faria \(2014\)](#) explore prioritarianism and egalitarianism qualitatively and conclude that both would imply priority for animals because animals are usually worse off compared to humans. This would mean, for instance, veganism and a considerable shift of resources towards animals ([Faria, 2014](#); [Horta, 2016](#)). However, whether animals actually are worse off compared to humans depends on the assumptions in the previous steps, especially regarding welfare capacities, normalization and weighting. For example, as noted by [Horta \(2016\)](#) and [Faria \(2014\)](#), [Vallentyne \(2005\)](#) proposes hierarchical weighting to prevent excessive resource shifts towards animals in the egalitarian setting. Leaving aside the issue that Vallentyne's approach entails double-discounting ([Schukraft, 2020a](#); see [Section 3.2.1](#)), [Faria \(2014\)](#) considers hierarchical weighting generally incompatible with egalitarianism. [Horta \(2016\)](#) is not so apodictic and merely stresses that welfare capacity should be all that matters in welfare economics. As [Vallentyne's \(2005\)](#) hierarchical weighting is based on welfare capacity, it could be considered compatible with egalitarianism.

3.2.3 *What is the welfare impact of increasing or decreasing the number of animals kept for farming purposes?*

- A) Societal welfare can be increased by removing animals with negative welfare, or by adding animals with positive welfare

This assumption entails either an impersonal view on societal welfare where only the total quantity of welfare counts and different individuals can replace each other, or it entails comparing individual welfare with non-existence ([Visak, 2011](#): 226, 236). Both situations are contested because either individual identity does not count or because individual welfare is compared to a state in which the individual simply does not have welfare because it does not exist (e.g. [Visak, 2016](#) versus [Holtug, 2016](#)). In particular, there is strong criticism against treating the neutral welfare state where welfare is zero (see [Section 3.1.4](#)) in the same way as non-existence (as practiced by [Kuruc and McFadden, 2023b](#)), or in the same way as non-existence and death (as practiced by [Espinosa and Treich, 2024b,c](#)). This is criticized because the neutral welfare state is something individuals can actually experience, while non-existence is not ([Visak, 2016](#)), and death is again different because it entails existence coming to an end (further discussed below). To illustrate the criticism: If it is true that individuals feel neutral most of the time because positive and negative welfare states have high energy costs (as suggested by [Ng, 1995](#), and recalled by [Treich, 2022](#)), then life would be equal to non-existence or death most of the time, which appears counterintuitive.

When it comes to removing animals from the population, it is generally distinguished between preventing to bring them into existence, or killing them

(e.g. [Visak, 2011](#): 230–1; [Blackorby and Donaldson, 1992](#)). Killing entails possible suffering due to a painful killing method and/or the ‘harm of death’ which refers to the future welfare loss of the individuals ([Visak, 2022](#): 89). The extent to which animals experience harm of death is controversially disputed and relates, for example, to the species’ degree of connectedness to their future in terms of future plans and desires (e.g. [Belshaw, 2016](#); [Bradley, 2016](#); reviewed by [Visak, 2022](#): 88–96 and by [Schukraft, 2020a](#)).

In total utilitarianism, animals with negative welfare should not be brought into existence or should be killed, while animals with positive welfare should be added and may be killed if replaced by other animals with positive welfare ([Visak, 2011](#): 227). This constellation is known, and criticized, as the ‘logic of the larder’ (e.g. [Visak, 2011](#); [Visak and Garner, 2016](#); [Espinosa and Treich, 2024b,c](#)). [Kuruc and McFadden \(2023b\)](#) and [Eichner and Runkel \(2022\)](#) try to avoid these implications by focusing on negative welfare states (see [Section 3.1.4](#)). [Espinosa and Treich \(2024c\)](#) mention critical-level utilitarianism as an alternative. Generally, critical-level utilitarianism arrives at the same results as total utilitarianism if the critical threshold corresponds to the neutral welfare state ([Kuruc and McFadden, 2023b](#); [Espinosa and Treich, 2024b,c](#)). However, if the critical threshold lies above neutrality, there will be animals with positive welfare whose lives are worth living but who do not increase societal welfare ([Blackorby and Donaldson, 1991](#); [Espinosa and Treich, 2024c](#)). The production of these animals with positive below-threshold welfare would not have to be increased ([Espinosa and Treich, 2024c](#)), but instead, these animals should be prevented from being brought into existence or killed, depending on whether societal welfare is assessed separately with and without these animals or before and after across time ([Blackorby and Donaldson, 1991](#)).¹⁹ Either way, it may seem troublesome to deprive individuals from positive experiences, just because they do not increase societal welfare ([Blackorby and Donaldson, 1991](#); [Holtz, 2016](#); [Visak, 2016](#)).

- B) Preventing individuals from being brought into existence, or adding individuals, does not affect societal welfare, whereas killing does affect societal welfare.

This assumption is in line with the person-affecting view, where comparisons with non-existence are not possible and individuals cannot replace each other (e.g. [Visak, 2022](#): 104). Hence, the logic of the larder (i.e. animal farming has to be expanded if animals have positive welfare) is avoided under this assumption ([Visak, 2016](#); [Bruers, 2022](#)).

Different refinements of person-affecting approaches have been proposed in the literature, each with their own advantages and disadvantages. These include ‘prior-existence utilitarianism’ (e.g. [Visak, 2011, 2016](#); see [Section 3.2.2](#)), ‘neutral-range utilitarianism’, ‘variable critical-level utilitarianism’ ([Bruers, 2022](#); see [Section 3.2.2](#)), and ‘saturating-counterpart

¹⁹The same also holds for average utilitarianism, relating everything to the average instead of the critical threshold ([Blackorby and Donaldson, 1991](#)).

person-affecting utilitarianism' (Visak, 2016). The latter maps individuals that exclusively exist in one of the scenarios to counterpart individuals in other scenarios (Visak, 2016). Thereby, in certain desirable instances, the same conclusions are reached as with impersonal approaches, but the logic of the larder and other undesirable consequences are avoided (Visak, 2016).

Like in this section's assumption A, death and killing affect the welfare of individuals in person-affecting approaches, and it constitutes a welfare loss if animals are deprived of positive experiences because their lives end prematurely. There are several methods to account for this welfare loss, for example, metrics in analogy to human disability-adjusted life years (DALYs) (e.g. Minetto Gellert Paris *et al.*, 2024 and 2022 based on Scherer *et al.*, 2018; Teng *et al.*, 2018; Weathers *et al.*, 2020).²⁰ Further, critical-level utilitarianism based on lifetime welfare penalizes early slaughter because older animals accumulate positive welfare and exceed the critical threshold more easily (Blackorby and Donaldson, 1992).

When animals face a life with negative welfare, the person-affecting approaches do not offer recommendations whether these individuals should be brought into existence or not, because comparisons with non-existence are just not possible (Visak, 2016). However, once these animals do exist, it can be required to kill them also under the person-affecting views in order to increase societal welfare (Visak, 2016). This dilemma, i.e. that it cannot be prevented to bring individuals into existence who will have miserable lives, is a major drawback of the person-affecting approaches and one of the reasons why they are often considered unacceptable in the literature (Arrhenius, 2009; Greaves, 2017). Therefore, person-affecting approaches are either fully dropped or opened up to resemble impersonal approaches by allowing limited comparisons with non-existence (Arrhenius, 2009), or other workarounds are explored by individual authors (e.g. by Visak, 2016).

3.2.4 *Should any additional constraints be applied?*

It is possible to restrict the aggregation rules with constraints that reflect fundamental ethical convictions in society, even if these convictions go against the principles of the aggregation rules (e.g. Adler, 2019: 25–7; Budolfson and Spears, 2020). Such constraints can also be seen as rights that protect individuals from certain consequences of welfarist policy evaluations (e.g. Francione, 2010; Adler, 2019: 26; Kuruc and McFadden, 2023b). For example, the right to life protects humans from being killed for biomedical experiments, even if such experiments resulted in a cure for cancer and were endorsed by some utilitarians (Francione, 2010).

²⁰These methods can also be applied in connection with assumption A, but they are more relevant for assumption B because the welfare loss cannot be compensated by bringing additional animals into existence.

A) Additional constraints

Visak (2011, 2016) and Bruers (2022) exclude individuals from aggregation if they do not exist in all policy scenarios. Besides, Bruers (2022) restricts the choice options available to individuals. Both authors do this to avoid certain undesirable consequences of the aggregation rules like the logic of the larder or the Repugnant Conclusion (see Sections 3.2.2 and 3.2.3).

Kuruc and McFadden (2023b) briefly mention that a ban on killing animals could be modelled in their approach as an additional cost, similar to a financial sanction for violations of the ban.

B) No additional constraints

An important reason against the application of constraints is that policy evaluations may no longer be impartial because welfare impacts are evaluated differently depending on which individuals experience them (e.g. Adler, 2019: 25). For example, it may be considered partial, or even speciesist, that it is currently only prohibited to kill humans but not animals, assuming both have the same at stake (Francione, 2010).

3.2.5 *Should human altruistic welfare (from knowing that animals are treated in a certain way) be included in addition to animal welfare?*

Humans are capable of altruism, meaning they may derive positive or negative welfare from knowing that animals are treated in a certain way. Anthropocentric policy evaluations, like Espinosa and Treich (2024a) or Fleurbaey and van der Linden (2021), account for animal welfare only through human altruism. In non-anthropocentric policy evaluations, different positions exist as to whether human altruism should be included in addition to the animals' own welfare.

Human pure altruism accurately mirrors the animals' own welfare. Mathematically, pure altruism is an exact duplicate of animal welfare, with or without an additional weight to adjust how much pure altruism counts towards overall welfare in society (Marggraf, Masius and Rumpf, 2012; Espinosa and Treich, 2021, 2024c). In contrast, impure altruism means that humans have a distorted image of animal welfare. The welfare impacts humans assume animals are experiencing, and from which they derive altruistic welfare, may be partially or fully uncorrelated with the welfare impacts animals are actually experiencing (Marggraf, Masius and Rumpf, 2012; Espinosa, 2023).²¹

A) Do not include human altruistic welfare

The main reason against the inclusion of human altruism is that this would result in the double-counting of animals' interests (Lusk and Norwood, 2012;

²¹Some also consider warm glow, i.e. the positive feeling of contributing to a good cause regardless of whether the contribution actually achieves any outcome, as part of human impure altruism (e.g. Espinosa, 2023), while others consider warm glow as part of humans' private non-altruistic welfare (e.g. Lusk and Norwood, 2012).

Marggraf, Masius and Rumpf, 2012; Eichner and Runkel, 2022; Espinosa and Treich, 2023). Further, because human altruism is coupled to the animals' own welfare (i.e. altruistic welfare decreases if animal welfare decreases), the double-counting may lead to the undesirable situation that welfare gains for animals cannot be redistributed to humans without decreasing total societal welfare (Lusk and Norwood, 2012; Marggraf, Masius and Rumpf, 2012). Lusk and Norwood (2012) conclude from this that human altruism should not be included in addition to animal welfare when determining whether a policy increases total welfare or when assessing compensatory redistributions. In contrast, Marggraf, Masius and Rumpf (2012) consider it a viable option to include human altruism because they do not think it is necessary that redistributions have to be possible without decreasing total welfare. Marggraf, Masius and Rumpf (2012) only stress that it should be carefully assessed which redistributions from animals to humans actually happen in practice in order not to overestimate the positive impacts of animal welfare policies.²²

B) Include human altruistic welfare in addition to animal welfare

The main reasons to include human altruism in addition to animal welfare are (i) that an important part of human welfare would simply be left out otherwise (Lusk and Norwood, 2012; Marggraf, Masius and Rumpf, 2012), and (ii) that human altruism can be considered as a new, separate welfare entity that should be included next to the animals' own welfare (Eichner and Runkel, 2022 based on Ng, 1999).

Multiple studies feature the option to include pure altruism but do not take sides whether this would be desirable (Table 1). The most elaborate framework for human altruism in non-anthropocentric policy evaluations has been developed by Eichner and Runkel (2022). The authors model human altruism as a combination of *homo oeconomicus*, taking the level of animal welfare as exogenously given because consumers perceive their own impact on animal welfare as negligible, and of *homo kantianus*, where consumers make every food purchase according to what is the right thing to do and assume everybody is doing the same (Eichner and Runkel, 2022). The framework by Eichner and Runkel (2022) can be categorized as pure altruism, with an additional weight.

3.2.6 Which units should be used for aggregation?

Multiple studies do not address or specify the unit but rather provide a general framework for aggregation that would be compatible with any monetary or non-monetary unit (Table 1).

A) Non-monetary units

Budolfson *et al.* (2024) use QALYs to compare impacts on animals and humans. In addition, the authors also monetize these impacts. Fischer (2023)

²²Redistributions from animals to humans can happen in practice; for example, when animal welfare policies increase costs in one area (e.g. space per animal) and producers react by saving costs in a different welfare-relevant area (e.g. feed quality) (Norwood and Lusk, 2011: 217; Marggraf, Masius and Rumpf, 2012).

relies on DALYs to compare impacts across species, but he does not formally cover the topic of aggregation.

B) Monetary units

A number of studies use monetary units to aggregate and compare impacts across species (Table 1). In the studies by [Espinosa \(2023\)](#), [Rusman *et al.* \(2023\)](#) and [Espinosa and Treich \(2024b,c\)](#), QALYs and DALYs are used as the basis for monetization but the focus lies on the monetary values.

3.3 How should welfare units be converted into monetary units?

3.3.1 What is the basis for monetization?

Converting welfare units into monetary units requires to define a reference point that connects both units. The following reference points have been used in the literature.

A) Value of a human QALY or DALY

There is a large body of literature on the monetary value humans assign to one year of life in perfect health (QALY), or to avoiding the loss of one year of life due to death, illness or disability (DALY). These monetary values are based on humans' stated or revealed willingness to pay (reviewed by, e.g. [OECD, 2012](#); [Ryen and Svensson, 2015](#); [Stawasz, 2020](#)).

For animals, the human QALY and DALY values are simply discounted, either based on the reasoning that animals have a lower capacity for welfare, lower weight in society compared to humans and/or a lower utility of money (Table 1). Because the monetary values for animals are directly derived from human values of QALYs and DALYs, this non-anthropocentric approach entails some level of anthropocentric bias ([Stawasz, 2020](#)). Table 3 provides examples of monetary values from two parameterized studies.

B) International poverty line

The international poverty line (\$1.90/day until 2022) serves as the basis for monetization only in the study by [Kuruc and McFadden \(2023b\)](#) (Table 3). In this study, it is assumed that the welfare of one farm animal is equivalent to the welfare of one human living on \$1.00/day, i.e. below the international poverty line. [Kuruc and McFadden \(2023b\)](#) themselves note that this assumption is rather arbitrary, and they see it more as a proof of principle, with the possibility to further differentiate between farmed species, farm types, etc. in the future.

As for QALYs and DALYs, this non-anthropocentric approach entails some level of anthropocentric bias because the value of \$1.00/day is arbitrarily chosen without input from animals, using a poverty scale that is determined entirely by human action on global markets.

C) Market price of feed

In preferentialism, the marginal welfare of animals can be monetized by multiplying the quantity of valuable resources animals are willing to forego

Table 3. Monetary values for the welfare of chickens (conventional or organic).

	Espinosa and Treich (2024b)	Rusman <i>et al.</i> (2023)	Kuruc and McFadden (2023b)
Monetization approach	QALY Value of one day in perfect health for a human: 402 €/d	DALY Compensation cost for loss of one day for a human: 291 €/d	International poverty line Chicken’s life is equivalent to human life on \$1 per day (0.92€/d)
Monetary value Example: Chicken	Value of chicken’s lifetime welfare per kg chicken meat: ^a conventional: $v_1 = -62.19$ €/kg $v_2 = -17.02$ €/kg organic: $v_3 = -60.36$ €/kg $v_4 = -0.98$ €/kg	Compensation costs for conventional chicken’s welfare loss per kg chicken meat: $c = 22.01$ €/kg	External costs for conventional chicken’s lifetime welfare per kg chicken meat: ^b $c = 4106.89$ €/kg

^aWe converted the values to €/kg without making any additional assumptions than the study itself. The values v_1 , v_2 and v_3 , v_4 originate from different assumptions by Espinosa and Treich (2024b) on the welfare level below which the chicken’s life is no longer worth living.

^bWe converted the values to €/kg under the additional assumption that 100g of chicken meat contains 27.3g of protein (USDA, 2019), exchange rate: 1\$ ≈ 0.92€.

(e.g. feed; see Section 3.1.3) by the market prices of these resources (Table 1). Although not explicitly mentioned, this approach would also be compatible with Blackorby and Donaldson (1992) and Eichner and Runkel (2022).

The main advantage of the approach is that it uses animals’ actual preferences and their marginal rates of substitution between goods to inform monetization. However, only humans interact in markets and determine market prices. Hence, unless a “liquid interspecies market” (Keeler, 2016: 721) can be put in place, monetization based on market prices will entail some level of anthropocentrism.

To date, this monetization approach has not been adopted in a parameterized example.

3.3.2 Does the marginal utility of money differ between species?

When welfare units are converted into monetary units, it has to be decided whether the exchange rate (i.e. marginal utility of money) should differ between species.

A) Different marginal utility of money

Lusk and Norwood (2012) believe that the marginal utility of money is higher for animals than for humans because they consider it plausible that, for

example, an additional \$100 represents a small welfare increase for a middle-class human but a large welfare increase for a pig.

Kuruc and McFadden (2023b) place animals on the steep and humans on the flat segment of the same utility function of income, meaning animals have a higher marginal utility of money compared to humans. This also implies that animals could reach the same welfare level as humans if they received enough money.

The empirical and ethical weights in the studies by Budolfson *et al.* (2024), Espinosa and Treich (2024b,c) and Espinosa (2023) simultaneously also discount the value of money across species, resulting in a lower marginal utility of money for animals compared to humans. The authors do not comment on this, so that it remains unclear whether this is actually intended.

Similarly, Rusman *et al.* (2023: 65) rely on a “morally adjusted monetisation factor of a (human) DALY” to convert welfare units into monetary units based on neuron counts, but the authors do not specify whether this reflects different welfare capacities, weights and/or marginal utilities of money.

B) Same marginal utility of money

Johansson-Stenman (2018) assumes for simplicity that the marginal utility of money is the same for animals and humans (and also between human individuals).

Marggraf, Masius and Rumpf (2012) and Blackorby and Donaldson (1992) do not explicitly address it but from their formulas it becomes clear that they assume the same marginal utility of money across and within species.

Lusk and Norwood (2012) are more in favour of different marginal utilities of money, but for Kaldor–Hicks transfers between species to be possible, they have to assume the same marginal utility of money across and within species.

3.4 Surveys

Surveys on normative standpoints among the public are part of the literature on non-anthropocentric CBA and SWF (Table 4). Given the highly abstract and theoretical character of the topic, it is challenging to design survey questions and to interpret the results. For example, when asked about weights for animals, it is not clear whether respondents take these weights as ethical, whether they derive them from empirical reasoning, or whether they do not even see them as weights in the sense of this review but rather as differences in welfare capacities (Johansson-Stenman, 2018; Schukraft, 2020c). Similarly, in a complex survey on comparisons with non-existence, Bruers (2023) observes extreme outliers and sensitivity to excluded values, which makes him question the robustness of the results.

4 Discussion and conclusion

In this critical review, we present the current state of knowledge on the non-anthropocentric inclusion and monetization of animal welfare in CBA and

Table 4. Surveys on non-anthropocentric policy evaluations.

	Surveys
Welfare concept	Review by Bruckner (2020) : tentative conclusion that public beliefs are more in line with objective-good concept than unidimensional concepts
Welfare capacity	<p>Bruers (2024): Belgium, $n = 112$, preliminary results: confidence-weighted median of participants assign the same capacity for suffering as for humans to dogs, birds and salmon, and a lower capacity to shrimp, followed by flies</p> <p>Sentience Institute (2022): USA, $n = 1,532$: 85.4% of participants at least somewhat agree that farmed animals (species not specified) have roughly the same ability to feel pain and discomfort as humans</p> <p>Futureye (2018): Australia, $n = 1,521$: sentience of mammals (cattle, sheep, goats, pigs) > chicken > fish > crustaceans (no statistical analysis)</p>
Weights	<p>Bracke et al. (2023): Netherlands, expert survey: average agreement score 6.2 that animals and people should be weighted equally (0 not at all, 10 very much so, $n = 12$); qualitative results: lower weight for healthy nutrition, higher weight for excessive consumption</p> <p>Review by Schukraft (2020c): tentative conclusion that hierarchical view is common, i.e. lower weight for animals than humans, weights are differentiated by animal species</p> <p>Johansson-Stenman (2018): Sweden, $n = 1,072$: animal suffering, compared to human suffering, should count equally (49.3%), less (43.5%), more (3.2%), only via human altruism (3.2%), should not count at all (0.8%)</p> <p>Lusk and Norwood (2008): USA, $n = 651$: suffering of one human equals suffering of 8,489 to 14,310 farm animals (species not specified, range of means in different categories of respondents)</p>
Population size	<p>Bruers (2023): Belgium, $n = 301$: participants report their willingness to pay (or accept) to experience the lives of different animals during a deep sleep, instead of having no experiences at all</p> <p>Espinosa and Treich (2021): France, $n = 223$: participants assess for different husbandry systems whether, from the perspective of a broiler, life is worth living or whether it would be better not to be born</p>
Human altruism^a	Lusk and Norwood (2012) : USA, $n = 100$: few participants have strong altruism, resulting in large deviations between mean and median altruistic willingness to pay

Table 4. Continued

Surveys	
Monetization	Bruers (2023) : see above, humans assign monetary value to animals similar to QALY/DALY approach

^aStandard surveys on human willingness to pay for animal welfare capture a mix of human private welfare from consumption (e.g. taste of meat), human altruism towards animals (Lusk and Norwood, 2012; Espinosa, 2023) and even human altruism towards other humans (Espinosa, 2023).

SWF. We synthesize material from a variety of studies, each contributing to different steps of non-anthropocentric CBA and SWF. In a checklist, we present the different underlying, often conflicting, normative assumptions to be considered when conducting non-anthropocentric CBA and SWF. As this is an emerging research field, these assumptions are sometimes only presented as a proof of principle rather than defended in the studies, and the checklist serves as a knowledge base that can be expanded over time.

The three concepts of welfare (hedonism, preferentialism and objective good) all appear workable, though preferentialism and the objective-good concept have not been tested in parameterized studies²³ yet. Whichever concept is adopted, it remains a challenge to assess whether the capacity for welfare differs between species. Currently, the assumption of different capacities prevails in the literature, also observed by Visak (2022: 9). Yet, similar to Browning (2023) and Visak (2022), we believe that the arguments in favour of equal capacities are just as strong, and we do not consider this question as settled yet.

Compared to the sophisticated research in animal science, the indicators currently used in non-anthropocentric CBA and SWF to measure animals' welfare states in different husbandry systems are remarkably stylized. Animal-based indicators that measure impacts directly on the animals (e.g. lameness, injuries) are lacking, and welfare states are measured separately from welfare capacities. This means that possible differences in species' welfare capacities have to be represented through weights that are applied to measured welfare states in the aggregation steps. It is a key contribution of our critical review to highlight not only these connections between capacities and weights in the literature but also with utility of money. All serve to discount animals compared to humans—otherwise, Singer's principle of equal consideration (e.g. Singer, 2014: 86) would imply that animals' interests in not being eaten would outweigh humans' interests in consuming animal products.

The aggregation rules currently explored in parameterized studies imply that societal welfare can be increased merely by reducing the numbers of poorly reared animals. On the one hand, we are concerned that this may divert attention from improving the husbandry conditions of farmed animals. On the

²³Recall that we use the term 'parameterized study' when a theoretical framework is spelled out from beginning to end with empirical data for specific cases (see Section 3.1.1).

other hand, this also implies that animal numbers could be increased if animal welfare were positive. Depending on how positive the animals' lives get, this may even outweigh detrimental climate effects of increased animal production (Kuruc and McFadden, 2023b; Espinosa and Treich, 2024c). Therefore, more attention should be paid to parameterising the novel refined aggregation rules that better account for possible positive welfare of farmed animals.

Money is an appealing unit for aggregation because producers' costs are already measured in Euro. However, the non-anthropocentric monetization of animal welfare is still in its infancy, and monetary values in the literature differ considerably (Table 3), reflecting disparities in the underlying normative assumptions.

Throughout the review, we flag potential sources of anthropocentric bias that may arise in non-anthropocentric CBA and SWF when adopting the concept of welfare, choosing welfare indicators, normalization, through anthropocentric weights and monetization.

In view of the manifold options to carry out non-anthropocentric CBA or SWF, we endorse the use of sensitivity analyses to explore the impacts of different assumptions, like others have also suggested (e.g. Stawasz, 2020; Budolfson, Fischer and Scovronick, 2023; Budolfson *et al.*, 2024).

For some steps in non-anthropocentric CBA and SWF, public surveys give insights into normative standpoints among the public, though the scope is currently limited and methodological challenges remain.

Finally, while we see the potential merits of assessing impacts on humans and animals on the same scale, making these methods fit for practical application—given the current challenges and controversies—should not hold up progress in animal welfare policymaking. Using the (limited) available data to describe the animal welfare impacts of policies in words or in quantitative non-monetary units, as already sometimes practiced in CBA (see Section 1.2), can also provide a reasonable basis for decisions.

Supplementary data

Supplementary data are available at [ERAE](#) online.

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